CHARACTERISTICS OF THE CERN POLARIZED PROTON SOURCE

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(Presented by L. Dick)

The CERN polarized proton source[1-3] now produces an atomic beam of 2 x 10^{16} atoms/s. Its main characteristics are as follows (Fig 1 and 2) :

1) Dissociation of H_2 by RF at low pressure, 3 mm Hg.
2) Injection of H atoms into a quadrupole through a ring-shaped pyrex Laval nozzle.
3) Pumping at injection is by three 1,000 l/s mercury vapour pumps. (Diffusion pump oil exposed to the hydrogen atoms would polymerize in about 10 hours).
4) Separation of the atomic states in a 6 m long quadrupole with a magnetic field varying from 3,400 gauss (injection) to 150 gauss[1), 3)].

Fig. 3 shows a photograph, on molybdenum oxide, of the atomic beam coming out of the quadrupole. Two rings can be seen corresponding to the hyperfine states of the H atom, F = 1, m = 1 (inner ring) and F = 1, m = 0 (outer ring). The rings are

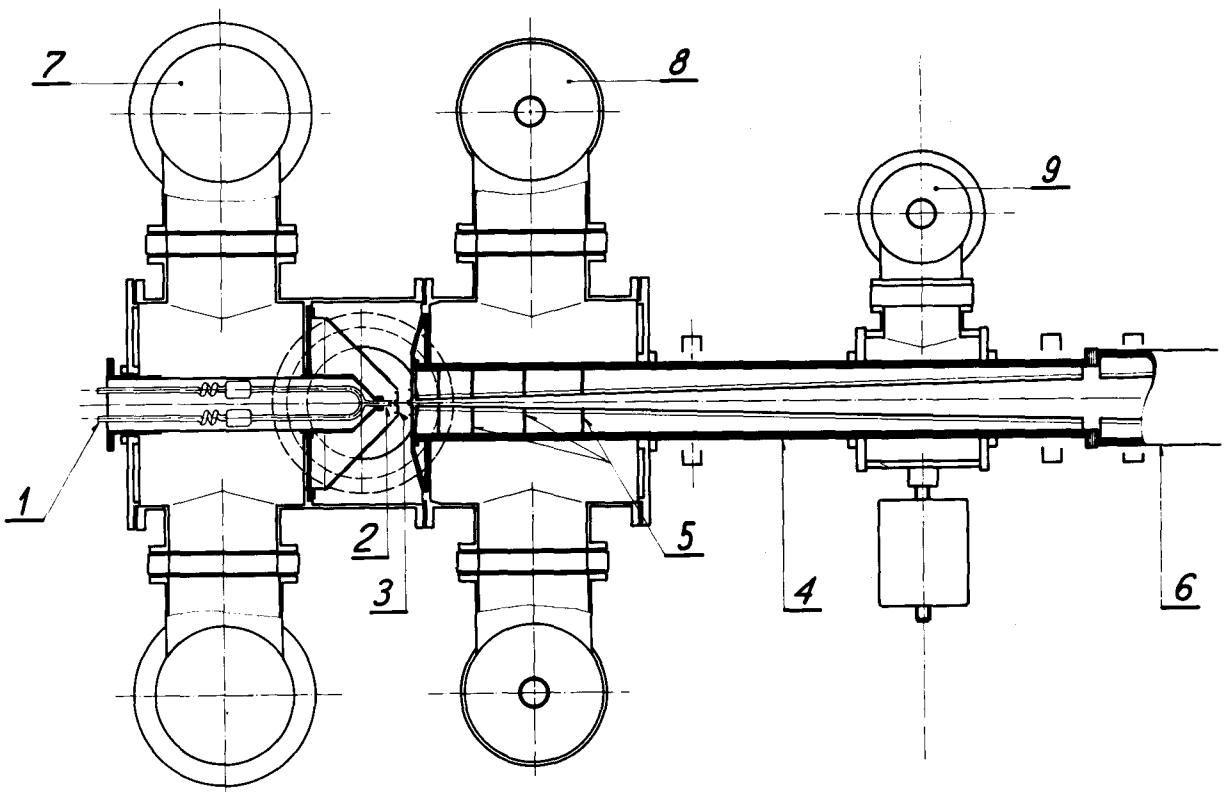

Fig. 1 First section of atomic jet 1) Dissociator; 2) Laval nozzle; 3) Peeler; 4) First quadrupole with permanent magnets; 5) Diaphragms; 6) Second quadrupole with permanent magnets; 7) Mercury vapour pumps; 8) and 9) Oil diffusion pump.

2.5 cm in diameter and 0.4 cm apart. Four diaphragms in the quadrupole eliminate the F = 1, m = 0 state.

The beam of polarized atomic hydrogen is directed to the centre of a 4.5 MeV cyclotron, where it is ionized by a perpendicular beam of electrons. The intensity of the accelerated beam measured on this small machine suggests that an intensity of 10^8 or 10^9 protons/s will be obtained in the 600 MeV external beam of the CERN SC.

In a synchro-cyclotron the ion source is not usually in the median plane, and at the beginning of the accelerating cycle there are many vertical oscillations which are symmetrical about the median plane. With the polarized proton source the atomic jet is in the median plane and the amplitude of ion oscillations in the centre of the machine should decrease considerably. A better acceptance of the ions can, therefore, be expected at the beginning of the accelerating cycle, and so can a greater efficiency of the regenerator for beam extraction, which acts as an oscillation filter.

To reduce the background of non-polarized protons due to the ionization of residual gas and particularly of water vapour, arrangements are being made to cool the centre of the SC[3] down to the temperature of liquid nitrogen. Fig. 4 shows the cooling system; it consists of two parallel plates opposite the dee and supporting, with sapphire cylindrical rods, two other plates located inside the dee. Circulating liquid nitrogen keeps the system at low temperature.

The complete source will be installed on the 600 MeV SC by the end of 1963.

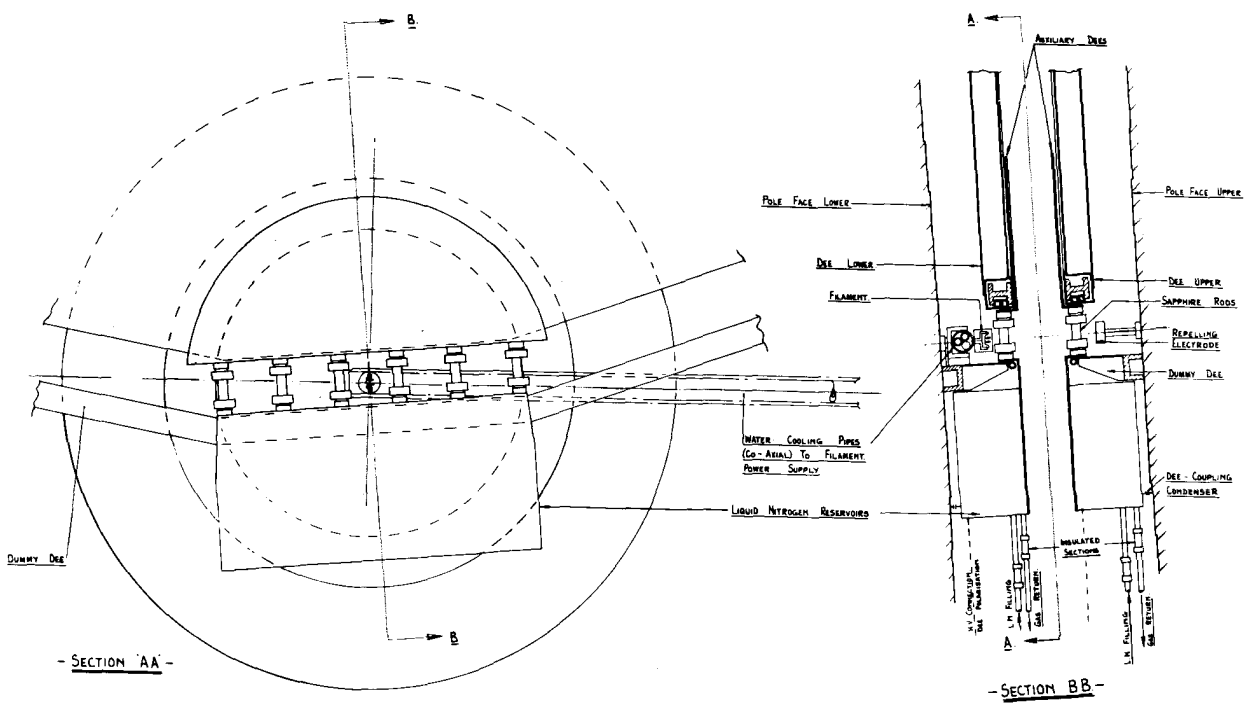

Fig. 4 Diagrammatic layout of cyclotron centre showing auxiliary dees etc. for extraction of polarized protons.

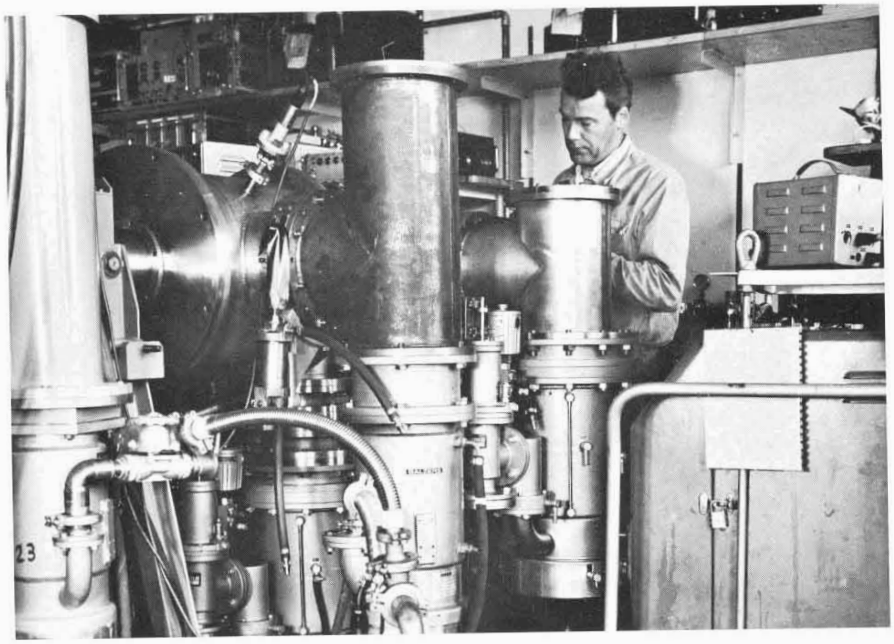

Fig. 2 First section of the polarized proton source.

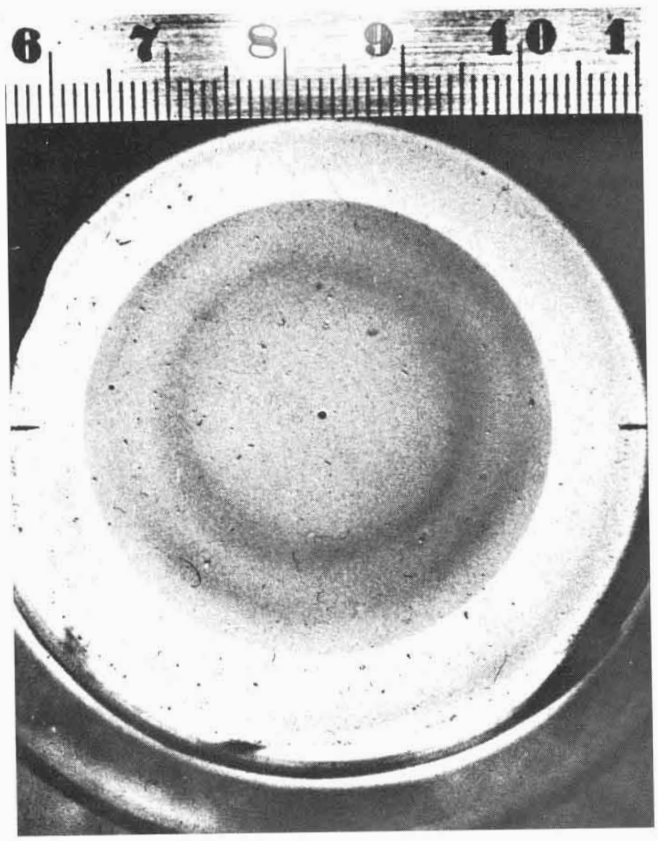

Fig. 3 Photograph of atomic jet.

References

1) R. Keller, Rapport CERN 57-30.
2) R. Keller, L. Dick, et M. Fidecaro, Rapport CERN 60-2.
3) R. Keller, L. Dick, and M. Fidecaro, International Symposium on Polarization, Helv. Phys. Acta, Suppl. VI, 1960.